Postharvest physiology of fresh-cut horticultural products

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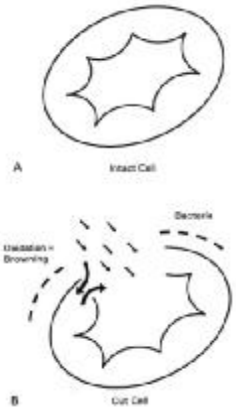
DEFINITION

POSTHARVEST PHYSIOLOGY

QUALITY OF FRESH-CUT PRODUCE

TECHNOLOGY OF PRODUCT PREPARATION

FUTURE PROSPECTS FOR RESEACH PLANS



DEFINITION of fresh-cut products

[previously called litle or minimally processed refrigerated products (MPR)]

are products that contain live tissues or those that have been only slightly modified from fresh condition and are like-fresh in character and quality.
Fresh-cut organic products.
These tissues do not exhibit the same physiological responses as normal raw untreated intact live plant tissues.

The fresh-cut F&V are defined as those prepared by a single or any number of appropriate unit operations such as peeling, slicing etc. given a partial but not end point preservation treatment including use of minimal heat, a preservative, or radiation.

Raw product

Fresh-cut

The quality of the raw material is one of the most essential factors determining the quality of the final product.

For hygienic reasons, no manure or fertilizers of animal origin should be used.

Criteria for *suitability of cultivars* to fresh-cut processing are:

- Processing yield
- Low sensitivity to physiological disorders and microbial diseases
- Mechanical resistance of the tissue
- Resistance to elevated CO_2 concentration
- High sugar contents
- Low respiration rate
- Special requirements

Careful harvesting

Harvest in the morning

Pre-cooled to 1°C as soon as possible after harvesting

Process within two days after harvesting

Importance:

Provide microbiologically safe food products ready to use or ready to cook with acceptable fresh-like quality characteristics + high nutritional value. There is growing demand for such products in the western civilization.

Advantages:

They are ready to use as fresh products

Prepared for restaurants, dining commons, fast food outlets and retail markets

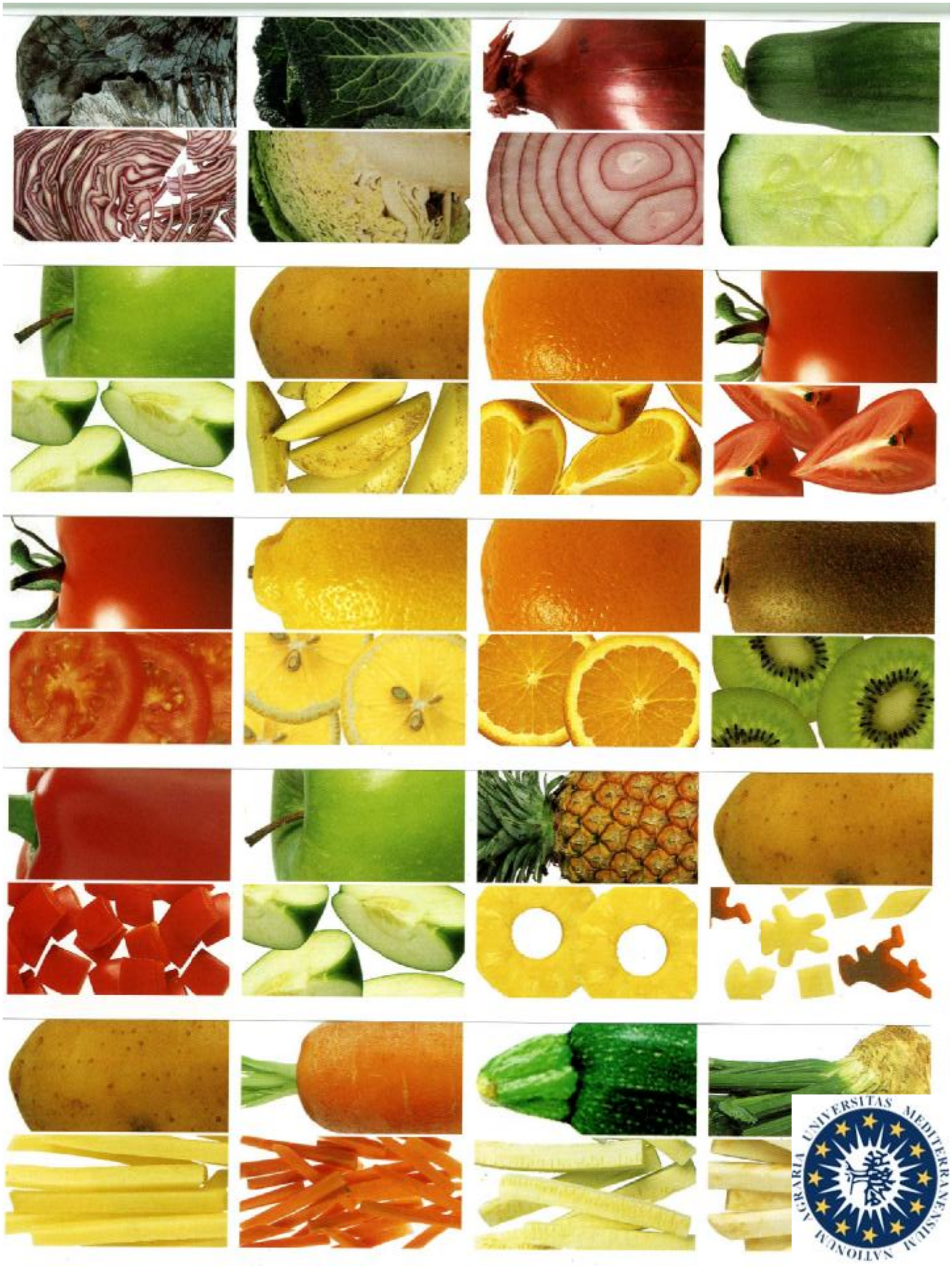
Consumer expectations:

Fresh-cut products to be:

- safe without defects,
- of optimum maturity and
- In fresh condition [general appearance, sensory quality (texture / firmness and taste) and nutrient quality]

Disadvantages:

- Limited shelf life (7-20 days)
- High microbial load (need to reduce it)
- High value products (cost of purchasing)



Characteristics of fresh-cur fruits and vegetables

List of changes

- Respiratory, metabolic and enzymatic activities
- Transpiration (moisture loss, weight loss)
- Growth phenomena
- Senescence (yellowing) in leafy vegetables
- Microbial spoilage
- Temperature-induced injuries
- Mechanical injuries

The fresh-cut F&V have a shorter shelf-life than the intact raw F&V. Example: the CA stored apples exhibit 6 to 8-month storage period, whereas the refrigerated sliced apples exhibit 2-3 weeks storage period

For safety and greatest retention of sensory quality and nutritional quality, these products must be distributed and marketed in the cool chain.

Refrigeration and packaging of fresh-cut are mandatory for the fresh-cut products.

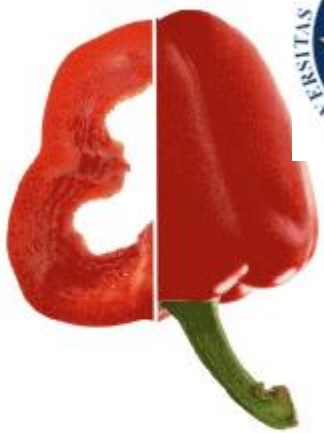
Major differences between:

Fresh-cut F&V and raw F&V are the specific processing and preservation steps taken in fresh-cut.

The fresh-cut are living respiring tissues but respiration is greatly increased by cutting, slicing etc.

The intact cell is more resistant to the oxidation browning and entrance of bacteria as compared to the cut cell.

The fresh-cut products has a short shelf life



Differences between fresh-cut and frozen foods

The frozen foods have not living tissues
The frozen foods must be transported and stored at -10°C or lower, whereas the fresh-cut products require higher temperatures
the overall quality of frozen foods is different from the quality of fresh-cut.

Differences between Fresh-cut and thermally processed foods

The fresh-cut do not exhibit «commercial stability*» as determined thermally processed foods (free of microorganisms).

*The microbial and enzyme limits for «microbial and enzymatic safety» are yet to be developed in the fresh-cut products.

Differences in nutritional and flavor quality.

Needs for knowledge of:

Postharvest Physiology
(essential is postharvest physiology of wounded tissues)

Food science

Technology

Postharvest Physiology

(It is ssentiall is postharvest physiology of wounded tissues)

Fresh-cut products are subject severe stress during the physical action of processing and are marked in conditions that can result in an undesirable product.

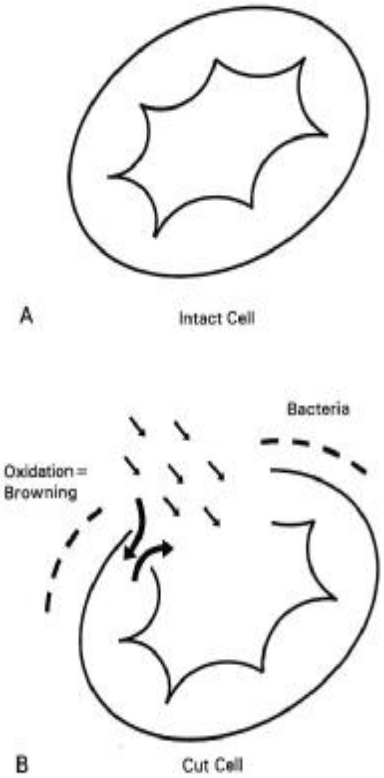
Minimally processing increases the rates of metabolic processes that cause deterioration of fresh-cut F&V.

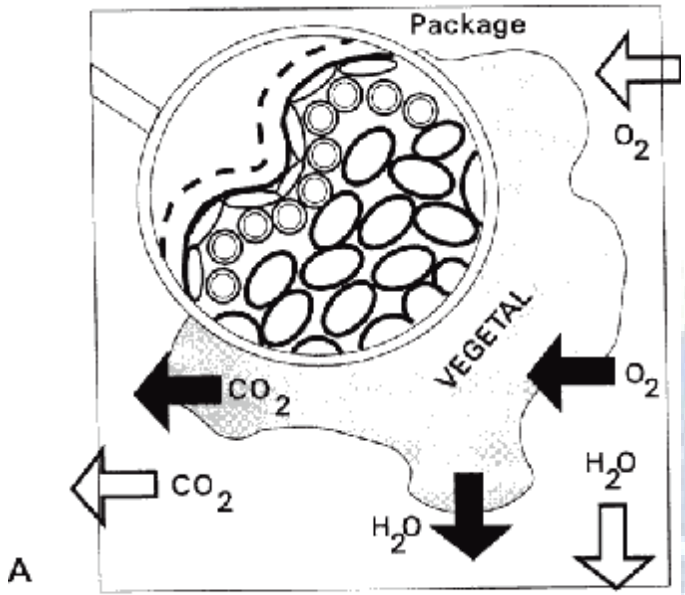
The physical damage of wounding causes in minutes:

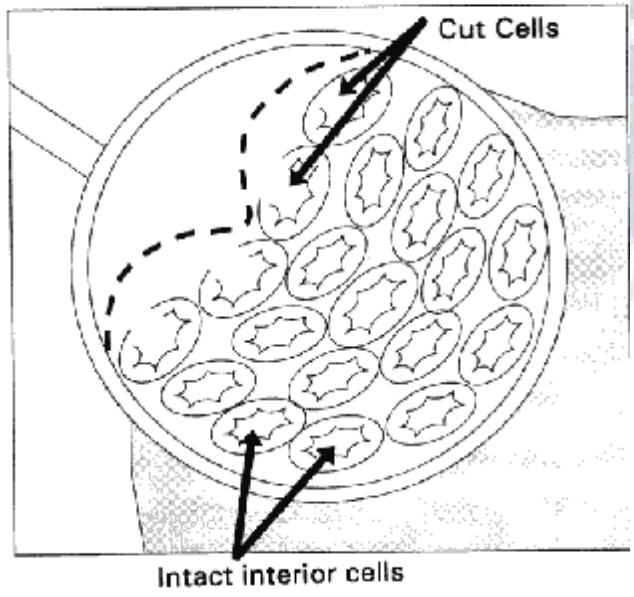
Increased respiration and ethylene production

Other biochemical reactions **à** changes in color (browning), flavor, texture and nutritional quality.

Senescence (yellowing) in leafy vegetables




Package
O_2
VEGETAL
CO_2
O_2
CO_2
H_2O
H_2O
A


Cut Cells
Intact interior cells
B

Problems: quality preservation

The fresh-cut products have short shelf life

due to:

Physiological breakdown

•browning,

•yellowing.

•softening

•water loss

Deterioration (rotting) by pathogens (bacteria, yeast and molds)

Loss of appearance and hardness

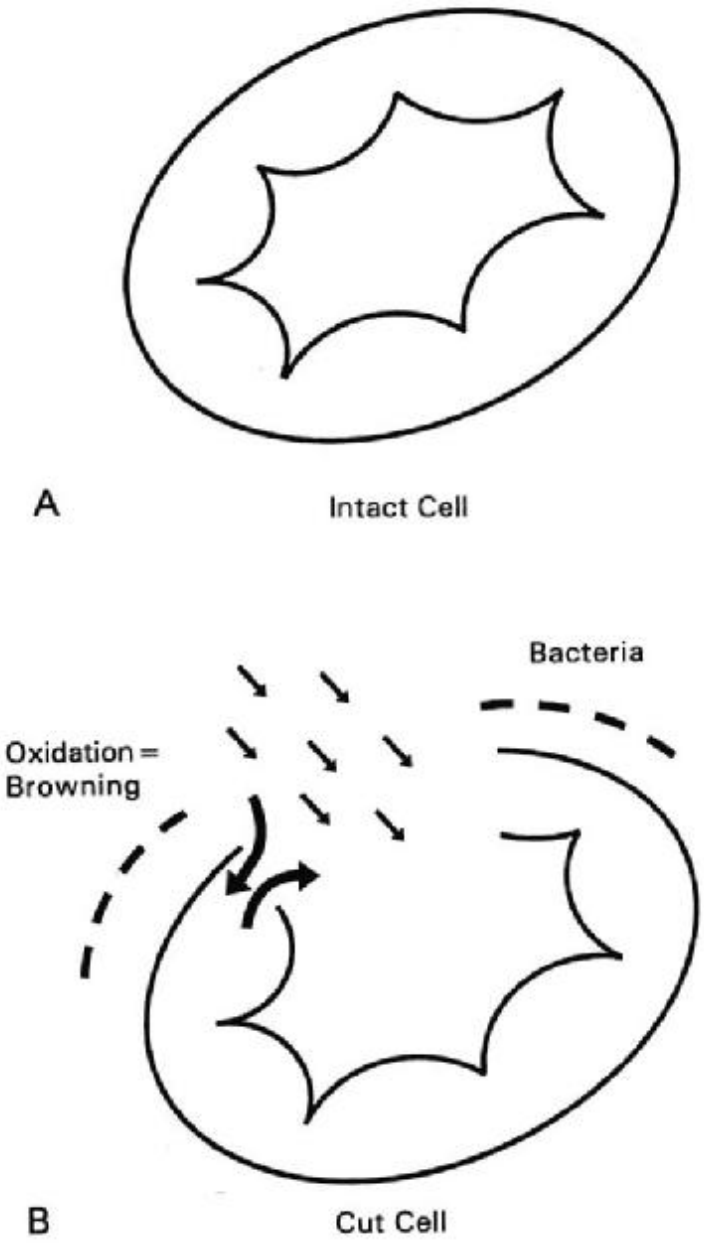
Loss of nutritional value (vitamins etc.)

The greatest the degree of processing, the greater the wounding response

Grape berries leaf salad shredded lettuce

Control of the wound response and the microbial stability are the keys to quality of fresh-cut F&V.

FACTORS ?



The intensity of the wound response is affected by:

species
variety
O2 and CO2
water pressure and
the presence of inhibitors

In fruits the wounding response is depended on state of maturity (climacteric stage)
The more advanced the ripeness stage, the more susceptible the fruit is to wounding during processing.
The optimal stage of processing to minimize cutting damage varies greatly depending on the species, cultivar, harvest and postharvest conditions

Browning is problem with cabbage, lettuce, apple and peach. Oxidation of phenols catalyzed by polyphenol oxidase (PO) results in the browning complex. Phenols are product of a reaction catalyzed by phenylalanine ammonia-lyase (the PAL activity is used as an index for the browning).

Example: Enzymatic browning of apples slices can be reduced by:

Treating with 0.2% $CaCl_2$

CA/MA delays browning

Cultivars differ in the degree of browning

Wounding induces:

PAL (phenylalanine ammonia-lyase activity

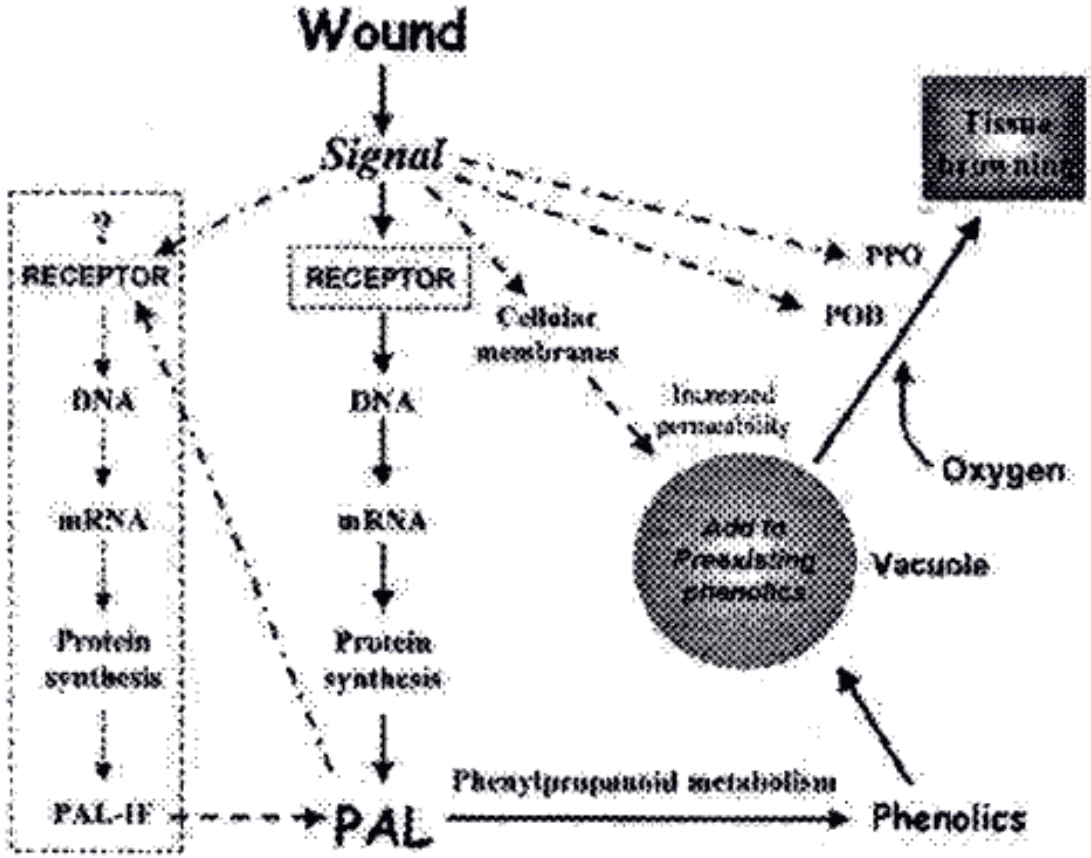
Changes in phenolic metabolism and browning

The mechanical and physical stresses (e.g. cutting, cracking, breaking) creates a wound signal ---> induces the synthesis of enzymes in metabolic pathways responsible for a number of physiological responses:

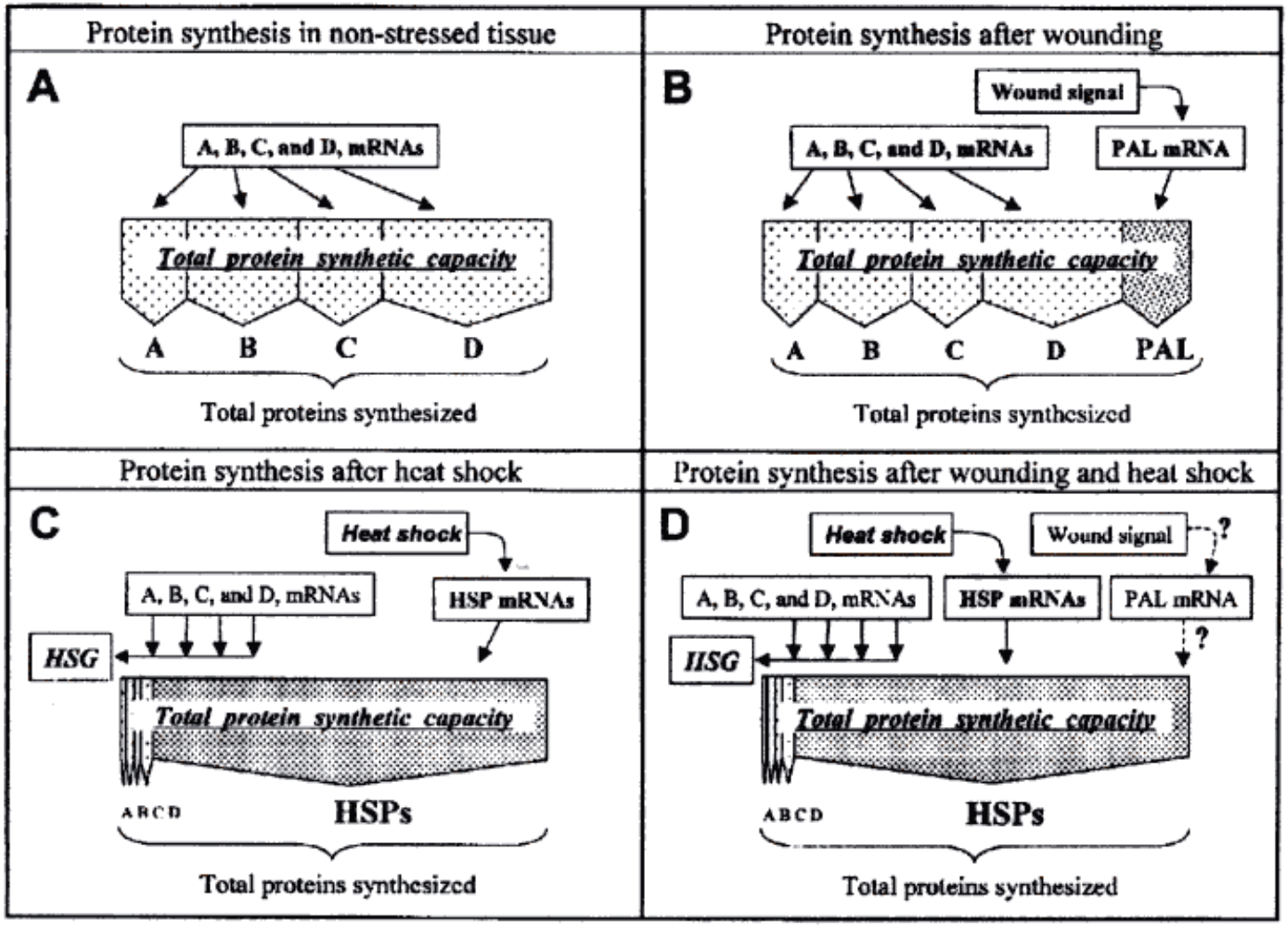
•PAL (the first enzyme for phenylpropanoid metabolism)

•accumulation of phenolic compounds (caffeic acid, chlorogenic acid, isochlorogenic acid, dicaffeoltartaric acid)

•browning of the tissues



In lettuce a brief heat shock at 45°C reduces the rise in the wound induced PAL, the accumulation of phenolic compounds, the browning. The synthesis of heat-shock proteins prevented PAL and browning response.



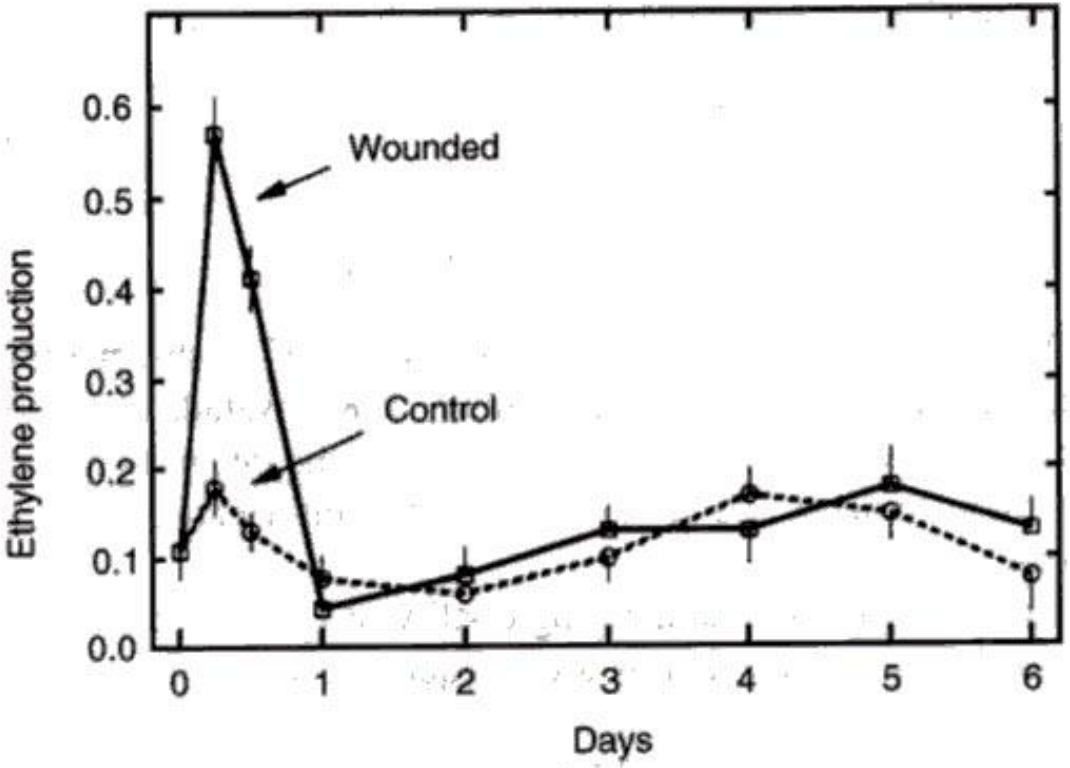
Ethylene sensitivity/production

Ethylene production is stimulated when plant tissues are injured and it can accumulated in packages of fresh-cut product and can induce undesirable effects (softening of kiwifruit, bitter taste in carrots, cabbage etc.)

Physiological effects of cutting on tissues

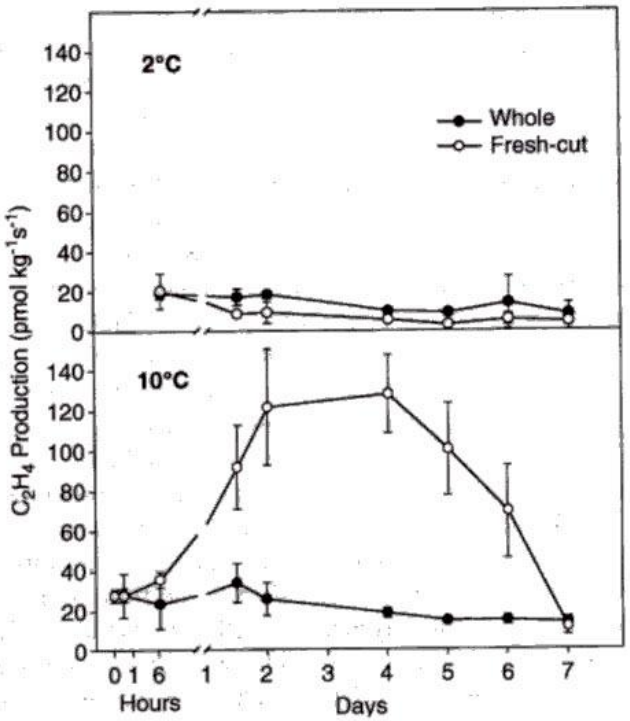
Ethylene production

Lettuce



Source: Ke and Salveit

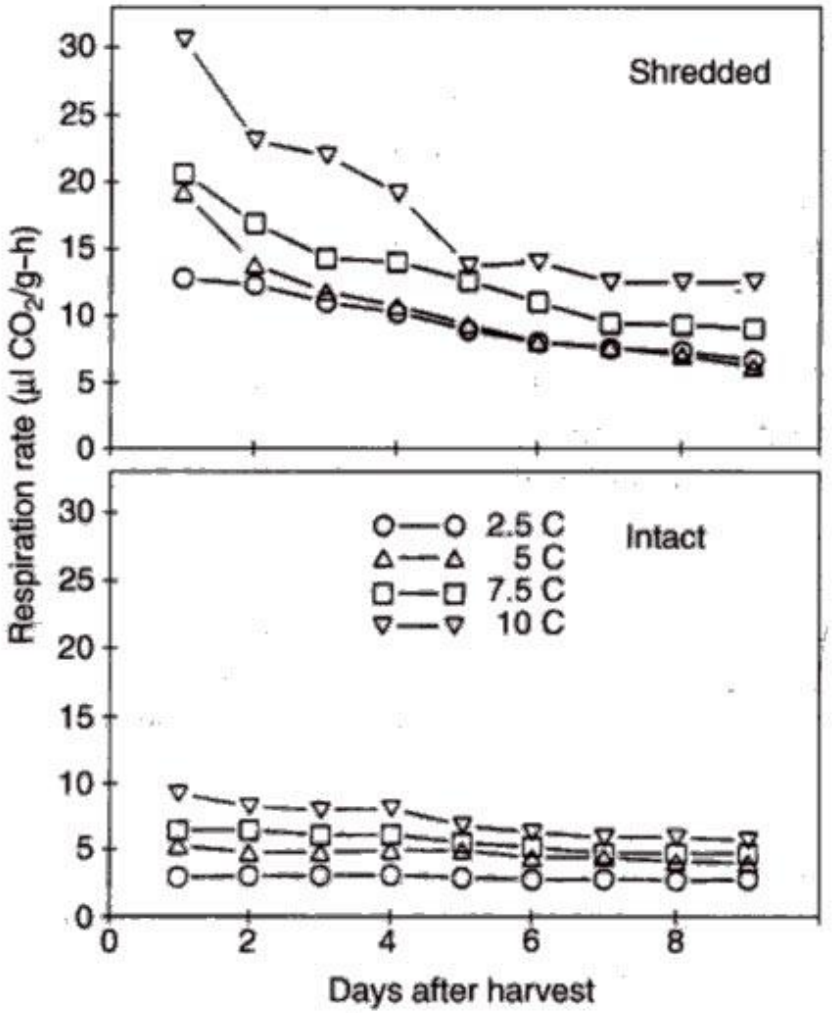
Tomato



Source: Artes et al. 1999

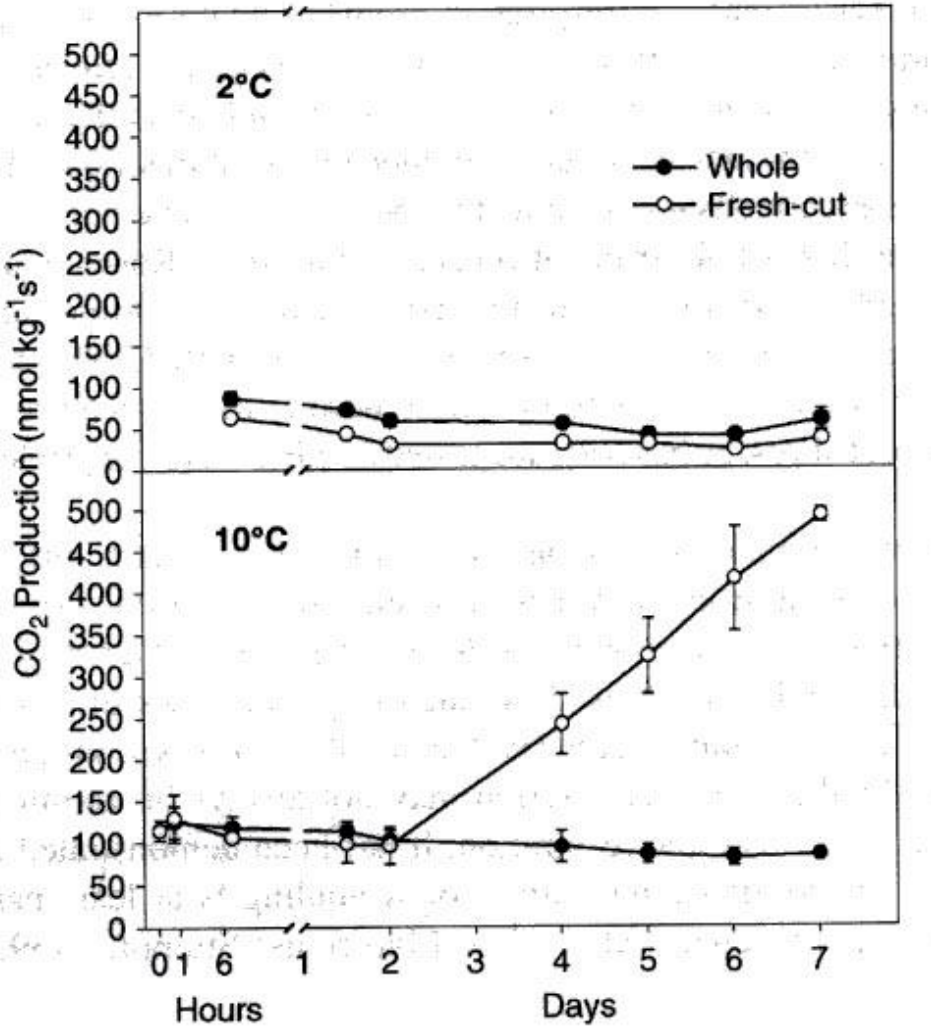
Effects on Respiration

Cabbage



Source: Cantwell, 1992

Tomato



Source: Artes et al. 1999

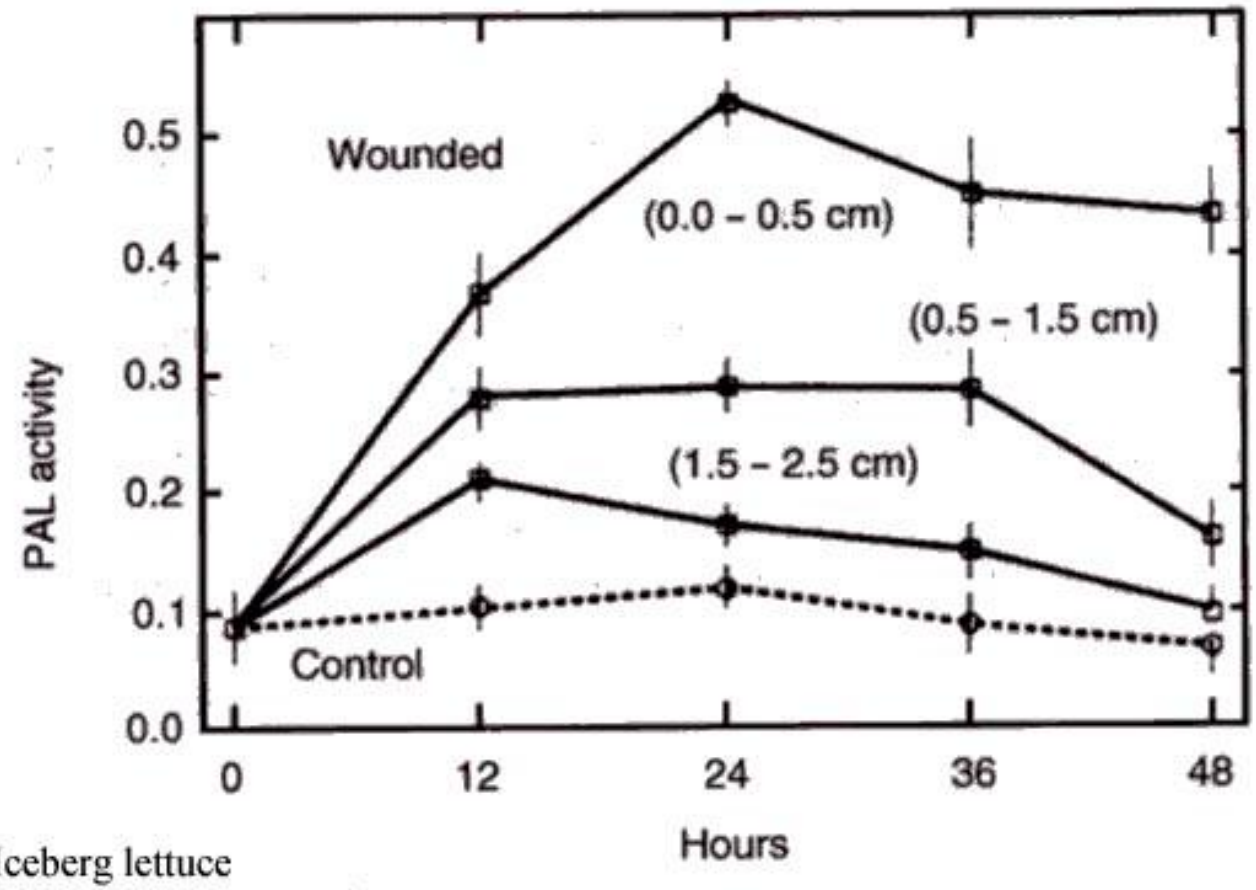
Effects on membrane deterioration

Secondary effects by membrane deterioration

Tissue browning

Development of off odors

Secondary metabolite accunulation



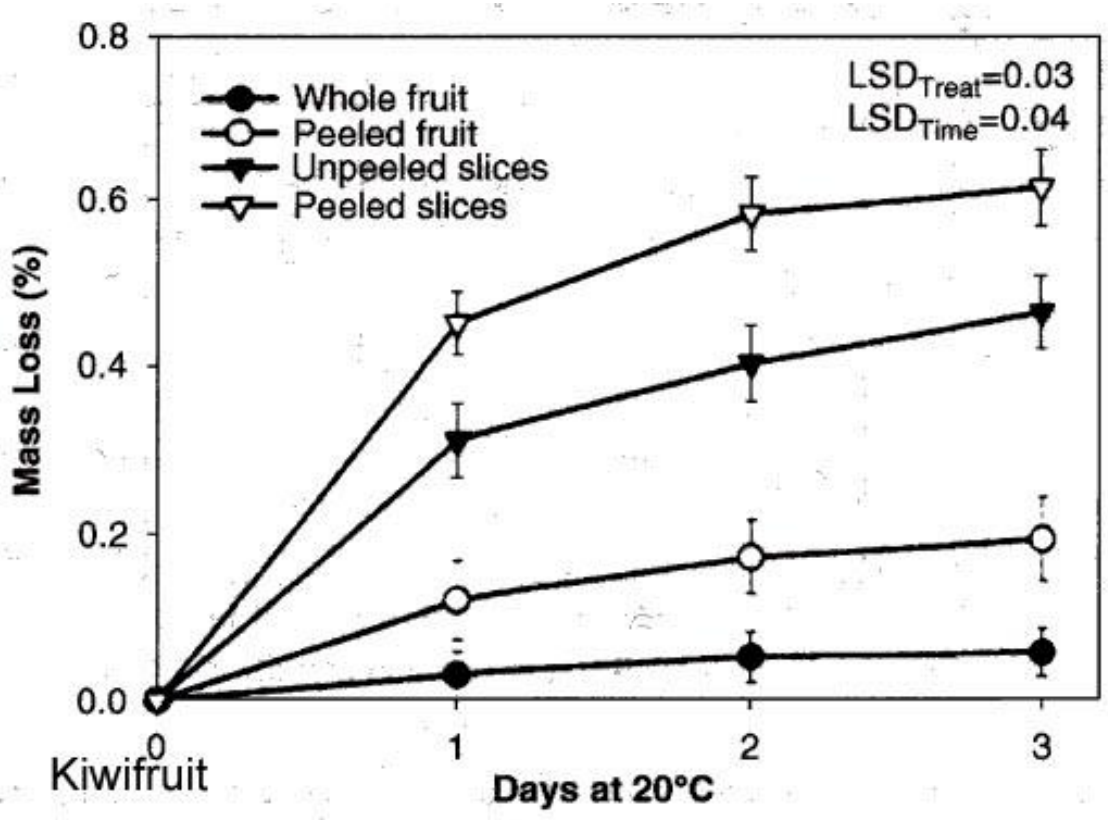
Iceberg lettuce

Phenolic accumulation

Increased activity of phenylalanine ammonia lyase

Sulfur containing compounds

Water loss



Source: Ke and Salveit, 1989

The removal of protective periderm by cutting or peeling results in increased rates of water loss

Susceptibility to microbial spoilage

QUALITY OF FRESH-CUT PRODUCE

Factors affecting quality of fresh-cut F&V

Temperature
CA/MA
Relative humidity
Microorganisms
Physiology and biochemistry
Technology

Factors affecting quality of fresh-cut F&V

Temperature (strict temperature control after processing critical)

The fresh-cut F&V are more perishable than the intact F&V because of physical stress (peeling, cutting, slicing etc.) and the removal of protective epidermal cells.

The fresh-cut F&V should be held at a lower T° than the recommended for the intact F&V (0°C, usually at 5°C and sometimes at 10°C).

The Q10 of biological reactions of fresh-cut is 3 to 4
At high temperatures physiological deterioration and microbial

growth is very high.

Relative humidity

The fresh-cut F&V have a large surface area without any skin, they are losing a substantial amount of weight. Needs in film-packed high RH.

Controlled atmosphere / Modified atmosphere

CA is not used for fresh-cut F&V because of the short handling period

MAP is mainly used

High CO_2 or low O_2 has a beneficial effect

Avoid anaerobic respiration

The phenylamonia lyase activity and phenolic compounds are lower in fresh-cut stored in MAP

Control of the wound response and the microbial stability are the keys to quality of fresh-cut F&V.

Microbial stability

Intact F&V are subject to safe eat because the surface peel is an effective barrier to most microorganisms.

On vegetables the microflora is contaminated by soil organisms (soil bacteria- *Erwinia* and *Pseudomonas*). Changing the environment (packaging) may result in microflora (pathogenic bacteria) such as *Clostridium*, *Listeria* etc.

With minimally processed products increased wounded area favorable for bacteria growth and risk of contamination (labor people).

A number of microorganisms have been found (mesophilic microflora, lactic acid bacteria, coliforms, yeasts and molds). The type and population differs with commodity, sanitation and cultural practices.

Microbial growth is controlled by:

- good sanitation,
- proper moisture,
- temperature,
- and other factors (CO2, O2) management.

Fresh-cut are rinsed in 50-200 ppm chlorine solution

(not all microorganisms are eliminated). They may survive when they are located within cells or areas not penetrated by the chemical

Alternative treatments have been studied to control microorganisms

(Heat treatments, fumigation with acetic acid, edible coatings etc.)

Summary

QUALITY OF FRESH-CUT PRODUCE

Highly perishable due to damage and exposure tissues and lack of protective skin

Disorders can be minimized by

the use of sharp cutting tools
enzymatic browning inhibitors
modified atmospheres

low temperature

Highly quality can be maintained by

selecting produce (cultivar, good initial Q)
proper maturity and
controlling deterioration by low T°C and MAP technology